EXHIBIT 10

Network Working Group   Luca Martini
Internet Draft   Nasser El-Aawar
Expiration Date: October 2002   Level 3 Communications, LLC.

Steve Vogelsang   Daniel Tappan
John Shirron   Eric C. Rosen
Toby Smith   Alex Hamilton
Laurel Networks, Inc.   Jayakumar Jayakumar
                                                    Cisco Systems, Inc.

Vasile Radoaca   Dimitri Stratton Vlachos
Nortel Networks   Mazu Networks, Inc.

Andrew G. Malis   Chris Liljenstolpe
Vinai Sirkay   Cable & Wireless
Vivace Networks, Inc.
                                                        Giles Heron
Dave Cooper   PacketExchange Ltd.
Global Crossing

                                                    Kireeti Kompella
                                                    Juniper Networks

                                                         April 2002

                   Transport of Layer 2 Frames Over MPLS

                   draft-martini-l2circuit-trans-mpls-09.txt

Status of this Memo

   This document is an Internet-Draft and is in full conformance with
   all provisions of Section 10 of RFC2026.

   Internet-Drafts are working documents of the Internet Engineering
   Task Force (IETF), its areas, and its working groups. Note that other
   groups may also distribute working documents as Internet-Drafts.

   Internet-Drafts are draft documents valid for a maximum of six months
   and may be updated, replaced, or obsoleted by other documents at any
   time. It is inappropriate to use Internet-Drafts as reference
   material or to cite them other than as "work in progress."

   The list of current Internet-Drafts can be accessed at
   http://www.ietf.org/ietf/1id-abstracts.txt.

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

    The list of Internet-Draft Shadow Directories can be accessed at
    http://www.ietf.org/shadow.html.

Abstract

    This document describes methods for transporting the Protocol Data
    Units (PDUs) of layer 2 protocols such as Frame Relay, ATM AAL5,
    Ethernet, and providing a SONET circuit emulation service across an
    MPLS network.

Table of Contents

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

1. Specification of Requirements

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
   document are to be interpreted as described in RFC 2119.

2. Introduction

   In an MPLS network, it is possible to carry the Protocol Data Units
   (PDUs) of layer 2 protocols by prepending an MPLS label stack to
   these PDUs. This document specifies the necessary label distribution
   procedures for accomplishing this using the encapsulation methods in
   [7]. We restrict discussion to the case of point-to-point transport.
   QoS related issues are not discussed in this draft. This document
   describes methods for transporting a number of protocols; in some
   cases, transporting a particular protocol may have several modes of
   operation. Each of these protocols and/or modes may be implemented
   independently.

   An accompanying document [8] also describes a method for transporting
   time division multiplexed (TDM) digital signals (TDM circuit
   emulation) over a packet-oriented MPLS network. The transmission
   system for circuit-oriented TDM signals is the Synchronous Optical
   Network (SONET)[5]/Synchronous Digital Hierarchy (SDH) [6]. To
   support TDM traffic, which includes voice, data, and private leased
   line service, the MPLS network must emulate the circuit
   characteristics of SONET/SDH payloads. MPLS labels and a new circuit
   emulation header are used to encapsulate TDM signals and provide the
   Circuit Emulation Service over MPLS (CEM).

3. Tunnel Labels and VC Labels

   Suppose it is desired to transport layer 2 PDUs from ingress LSR R1
   to egress LSR R2, across an intervening MPLS network. We assume that
   there is an LSP from R1 to R2. That is, we assume that R1 can cause a
   packet to be delivered to R2 by pushing some label onto the packet
   and sending the result to one of its adjacencies. Call this label the
   "tunnel label", and the corresponding LSP the "tunnel LSP".

   The tunnel LSP merely gets packets from R1 to R2, the corresponding
   label doesn't tell R2 what to do with the payload, and in fact if
   penultimate hop popping is used, R2 may never even see the
   corresponding label. (If R1 itself is the penultimate hop, a tunnel
   label may not even get pushed on.) Thus if the payload is not an IP
   packet, there must be a label, which becomes visible to R2, that
   tells R2 how to treat the received packet. Call this label the "VC

Martini, et al.   [Page 3]

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

label".

So when R1 sends a layer 2 PDU to R2, it first pushes a VC label on
its label stack, and then (if R1 is not adjacent to R2) pushes on a
tunnel label. The tunnel label gets the MPLS packet from R1 to R2;
the VC label is not visible until the MPLS packet reaches R2. R2's
disposition of the packet is based on the VC label.

Note that the tunnel could be a GRE encapsulated MPLS tunnel between
R1 and R2. In this case R1 would be adjacent to R2, and only the VC
label would be used, and the intervening network need only carry IP
packets.

If the payload of the MPLS packet is, for example, an ATM AAL5 PDU,
the VC label will generally correspond to a particular ATM VC at R2.
That is, R2 needs to be able to infer from the VC label the outgoing
interface and the VPI/VCI value for the AAL5 PDU. If the payload is a
Frame Relay PDU, then R2 needs to be able to infer from the VC label
the outgoing interface and the DLCI value. If the payload is an
Ethernet frame, then R2 needs to be able to infer from the VC label
the outgoing interface, and perhaps the VLAN identifier. This process
is unidirectional, and will be repeated independently for
bidirectional operation. It is REQUIRED to assign the same VC ID, and
VC type for a given circuit in both directions. The group ID (see
below) MUST NOT be required to match in both directions. The
transported frame MAY be modified when it reaches the egress router.
If the header of the transported layer 2 frame is modified, this MUST
be done at the egress LSR only.

Note that the VC label must always be at the bottom of the label
stack, and the tunnel label, if present, must be immediately above
the VC label. Of course, as the packet is transported across the MPLS
network, additional labels may be pushed on (and then popped off) as
needed. Even R1 itself may push on additional labels above the tunnel
label. If R1 and R2 are directly adjacent LSRs, then it may not be
necessary to use a tunnel label at all.

This document does not specify a method for distributing the tunnel
label or any other labels that may appear above the VC label on the
stack. Any acceptable method of MPLS label distribution will do.

This document does specify a method for assigning and distributing
the VC label. Static label assignment MAY be used, and
implementations SHOULD provide support for this. When signaling is
used, the VC label MUST be distributed from R2 to R1 using LDP in the
downstream unsolicited mode; this requires that an LDP session be
created between R1 and R2. It should be noted that this LDP session
is not necessarily transported along the same path as the Layer 2

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

PDUs. [1] In addition, when using LDP to distribute the VC label,
liberal label retention mode SHOULD be used. However, as required in
[1], the label request operation (mainly used by conservative label
retention mode) MUST be implemented. VC labels MUST be allocated from
the per-platform label space.

Note that this technique allows an unbounded number of layer 2 "VCs"
to be carried together in a single "tunnel". Thus it scales quite
well in the network backbone.

While this document currently defines the emulation of Frame Relay
and ATM PVC services, it specifically does not preclude future
enhancements to support switched service (SVC and SPVC) emulation.

4. Protocol-Specific Details

4.1. Frame Relay

The Frame Relay PDUs are encapsulated according to the procedures
defined in [7]. The MPLS edge LSR MUST provide Frame Relay PVC status
signaling to the Frame Relay network. If the MPLS edge LSR detects a
service affecting condition as defined in [2] Q.933 Annex A.5 sited
in IA FRF1.1, it MUST withdraw the label that corresponds to the
frame relay DLCI. The Egress LSR SHOULD generate the corresponding
errors and alarms as defined in [2] on the egress Frame relay VC.

4.2. ATM

4.2.1. ATM AAL5 VCC Transport

ATM AAL5 CSPS-SDUs are encapsulated according to [10] ATM AAL5 CPCS-
SDU mode. This mode allows the transport of ATM AAL5 CSPS-SDUs
traveling on a particular ATM PVC across the MPLS network to another
ATM PVC.

4.2.2. ATM Transparent Cell Transport

This mode is similar to the Ethernet port mode. Every cell that is
received at the ingress ATM port on the ingress LSR, R1, is
encapsulated according to [10], ATM cell mode, and sent across the
LSP to the egress LSR, R2. This mode allows an ATM port to be
connected to only one other ATM port. [10] allows for grouping of
multiple cells into a single MPLS frame. Grouping of ATM cells is
OPTIONAL for transmission at the ingress LSR, R1. If the Egress LSR

Martini, et al.   [Page 5]

R2 supports cell concatenation the ingress LSR, R1, should only
concatenate cells up to the "Maximum Number of concatenated ATM
cells" parameter received as part of the FEC element.

4.2.3. ATM VCC and VPC Cell Transport

This mode is similar to the ATM AAL5 VCC transport except that cells
are transported. Every cell that is received on a pre-defined ATM
PVC, or ATM PVP, at the ingress ATM port on the ingress LSR, R1, is
encapsulated according to [10], ATM cell mode, and sent across the
LSP to the egress LSR R2. Grouping of ATM cells is OPTIONAL for
transmission at the ingress LSR, R1. If the Egress LSR R2 supports
cell concatenation the ingress LSR, R1, MUST only concatenate cells
up to the "Maximum Number of concatenated ATM cells in a frame"
parameter received as part of the FEC element.

4.2.4. OAM Cell Support

OAM cells MAY be transported on the VC LSP. When the LSR is operating
in AAL5 CPCS-SDU transport mode if it does not support transport of
ATM cells, the LSR MUST discard incoming MPLS frames on an ATM VC LSP
that contain a VC label with the T bit set [10]. When operating in
AAL5 SDU transport mode an LSR that supports transport of OAM cells
using the T bit defined in [7], or an LSR operating in any of the
three cell transport modes MUST follow the procedures outlined in [9]
section 8 for mode 0 only, in addition to the applicable procedures
specified in [6].

4.2.4.1. OAM Cell Emulation Mode

AN LSR that does not support transport of OAM cells across an LSP MAY
provide OAM support on ATM PVCs using the following procedures:

A pair of LSRs MAY emulate a bidrectional ATM VC by two uni-
directional LSPs. If an F5 end-to-end OAM cell is received from a
ATM VC, by either LSR that is transporting this ATM VC, with a
loopback indication value of 1, and the LSR has a label mapping for
the ATM VC, then the LSR MUST decrement the loopback indication value
and loop back the cell on the ATM VC. Otherwise the loopback cell
MUST be discarded by the LSR.

The ingress LSR, R1, may also optionally be configured to
periodically generate F5 end-to-end loopback OAM cells on a VC. If
the LSR fails to receive a response to an F5 end-to-end loopback OAM
cell for a pre-defined period of time it MUST withdraw the label

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

mapping for the VC.

If an ingress LSR, R1, receives an AIS F5 OAM cell, fails to receive a pre-defined number of the End-to-End loop OAM cells, or a physical interface goes down, it MUST withdraw the label mappings for all VCs associated with the failure. When a VC label mapping is withdrawn, the egress LSR, R2, MUST generate AIS F5 OAM cells on the VC associated with the withdrawn label mapping. In this mode it is very useful to apply a unique group ID to each interface. In the case where a physical interface goes down, a wild card label withdraw can be sent to all LDP neighbors, greatly reducing the signaling response time.

4.2.5. ILMI Support

An MPLS edge LSR MAY provide an ATM ILMI to the ATM edge switch. If an ingress LSR receives an ILMI message indicating that the ATM edge switch has deleted a VC, or if the physical interface goes down, it MUST withdraw the label mappings for all VCs associated with the failure. When a VC label mapping is withdrawn, the egress LSR SHOULD notify its client of this failure by deleting the VC using ILMI.

4.3. Ethernet VLAN

The Ethernet frame will be encapsulated according to the procedures in [12]. It should be noted that if the VLAN identifier is modified by the egress LSR, according to the procedures outlined above, the Ethernet spanning tree protocol might fail to work properly. If the LSR detects a failure on the Ethernet physical port, or the port is administratively disabled, it MUST withdraw the label mappings for all VCs associated with the port.

4.4. Ethernet

The Ethernet frame will be encapsulated according to the procedures in [12]. If the LSR detects a failure on the Ethernet physical port, or the port is administratively disabled, the corresponding VC label mapping MUST be withdrawn.

4.5. HDLC

HDLC frames are encapsulated according to the procedures in [11]. If the MPLS edge LSR detects that the physical link has failed, or the port is adminstratively disabled, it MUST withdraw the label mapping that corresponds to the HDLC link.

Martini, et al.   [Page 7]

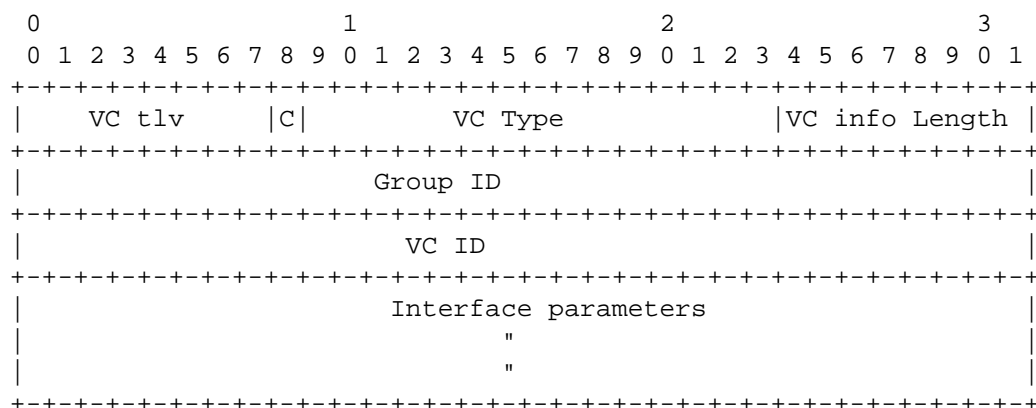Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

4.6. PPP

   PPP frames are encapsulated according to the procedures in [11]. If
   the MPLS edge LSR detects that the physical link has failed, or the
   port is adminstratively disabled, it MUST withdraw the label mapping
   that corresponds to the PPP link.

5. LDP

   The VC label bindings are distributed using the LDP downstream
   unsolicited mode described in [1]. The LSRs will establish an LDP
   session using the Extended Discovery mechanism described in [1,
   section 2.4.2 and 2.5], for this purpose a new type of FEC element is
   defined. The FEC element type is 128. [note1] Only a single VC FEC
   element MUST be advertised per LDP VC label. The Virtual Circuit FEC
   element, is defined as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|    VC tlv     |C|            VC Type        |VC info Length |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Group ID                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           VC ID                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Interface parameters                    |
|                             "                               |
|                             "                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```


   - VC Type

     A 15 bit quantity containing a value which represents the type of
     VC. Assigned Values are:

            VC Type   Description

            0x0001   Frame Relay DLCI
            0x0002   ATM AAL5 VCC transport
            0x0003   ATM transparent cell transport
            0x0004   Ethernet VLAN
            0x0005   Ethernet
            0x0006   HDLC
            0x0007   PPP
            0x8008   CEM [8]

Martini, et al.   [Page 8]

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

                    0x0009   ATM VCC cell transport
                    0x000A   ATM VPC cell transport

        - Control word bit (C)

          The highest order bit (C) of the VC type is used to flag the
          presence of a control word (defined in [7]) as follows:
                    bit 15 = 1 control word present on this VC.
                    bit 15 = 0 no control word present on this VC.

          Please see the section "C Bit handling procedures" for further
          explenation.

        - VC information length

          Length of the VC ID field and the interface parameters field in
          octets. If this value is 0, then it references all VCs using the
          specified group ID and there is no VC ID present, nor any
          interface parameters.

        - Group ID

          An arbitrary 32 bit value which represents a group of VCs that is
          used to create groups in the VC space. The group ID is intended
          to be used as a port index, or a virtual tunnel index. To
          simplify configuration a particular VC ID at ingress could be
          part of the virtual tunnel for transport to the egress router.
          The Group ID is very useful to send wild card label withdrawals
          to remote LSRs upon physical port failure.

        - VC ID
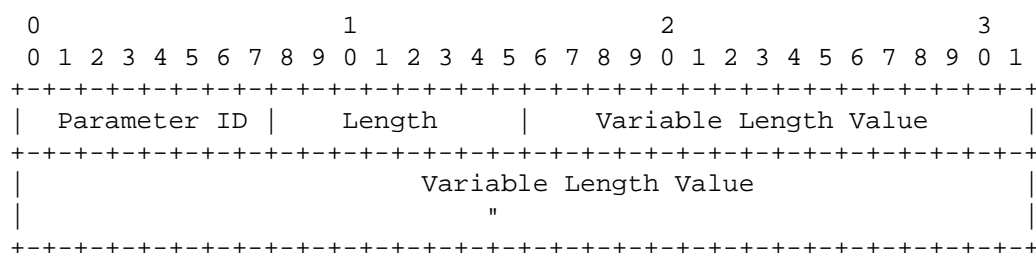
          A non zero 32-bit connection ID that together with the VC type,
          identifies a particular VC.

        - Interface parameters

          This variable length field is used to provide interface specific
          parameters, such as interface MTU.

Martini, et al.   [Page 9]

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

5.1. Interface Parameters Field

   This field specifies interface specific parameters. When aplicable,
   it MUST be used to validate that the LSRs, and the ingress and egress
   ports at the edges of the circuit, have the necessary capabilities to
   interoperate with each other. The field structure is defined as
   follows:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   | Parameter ID |   Length    |    Variable Length Value      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                     Variable Length Value                    |
   |                              "                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

   The parameter ID is defined as follows:
   Parameter   ID Length   Description

      0x01   4   Interface MTU in octets.
      0x02   4   Maximum Number of concatenated ATM cells.
      0x03   up to 82   Optional Interface Description string.
      0x04   4   CEM [8] Payload Bytes.
      0x05   4   CEM options.

   The Length field is defined as the length of the interface parameter
   including the parameter id and length field itself.

     - Interface MTU

       A 2 octet value indicating the MTU in octets. This is the Maximum
       Transmission Unit, excluding encapsulation overhead, of the
       egress packet interface that will be transmitting the
       decapsulated PDU that is received from the MPLS network. This
       parameter is applicable only to VC types 1, 2, 4, 5, 6, and 7,
       and is REQUIRED for these VC types. If this parameter does not
       match in both directions of a specific VC, that VC MUST NOT be
       enabled.

     - Maximum Number of concatenated ATM cells

       A 2 octet value specifying the maximum number of concatenated ATM
       cells that can be processed as a single PDU by the egress LSR. An
       ingress LSR transmitting concatenated cells on this VC can
       concatenate a number of cells up to the value of this parameter,
       but MUST NOT exceed it. This parameter is applicable only to VC

Martini, et al.   [Page 10]

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

       types 3, 9, and 0x0a, and is REQUIRED for these VC types. This
       parameter does not need to match in both directions of a specific
       VC.

     - Optional Interface Description string

       This arbitrary, OPTIONAL, interface description string can be
       used to send an administrative description text string to the
       remote LSR. This parameter is OPTIONAL, and is applicable to all
       VC types. The interface description parameter string length is
       variable, and can be from 0 to 80 octets.

     - Payload Bytes

       A 2 octet value indicating the the number of TDM payload octets
       contained in all packets on the CEM stream, from 48 to 1,023
       octets. All of the packets in a given CEM stream have the same
       number of payload bytes. Note that there is a possibility that
       the packet size may exceed the SPE size in the case of an STS-1
       SPE, which could cause two pointers to be needed in the CEM
       header, since the payload may contain two J1 bytes for
       consecutive SPEs. For this reason, the number of payload bytes
       must be less than or equal to 783 for STS-1 SPEs.

     - CEM Options. An optional 16 Bit value of CEM Flags. See [8] for
       the definition of the bit values.

5.2. C Bit handling procedures

5.2.1. VC types for which the control word is REQUIRED

   The Label Mapping messages which are sent in order to set up these
   VCs MUST have c=1. When a Label Mapping message for a VC of one of
   these types is received, and c=0, a Label Release MUST be sent, with
   an "Illegal C-bit" status code. In this case, the VC will not come
   up.

5.2.2. VC types for which the control word is NOT mandatory

   If a system is capable of sending and receiving the control word on
   VC types for which the control word is not mandatory, then each such
   VC endpoint MUST be configurable with a parameter that specifies
   whether the use of the control word is PREFERRED or NOT PREFERRED.
   For each VC, there MUST be a default value of this parameter. This
   specification does NOT state what the default value should.

Martini, et al.   [Page 11]

If a system is NOT capable of sending and receiving the control word
on VC types for which the control word is not mandatory, then it
behaves as exactly as if it were configured for the use of the
control word to be NOT PREFERRED.

If a Label Mapping message for the VC has already been received, but
no Label Mapping message for the VC has yet been sent, then the
procedure is the following:
- -i. If the received Label Mapping message has c=0, send a Label
       Mapping message with c=0, and the control word is not used.
- -ii. If the received Label Mapping message has c=1, and the VC is
       locally configured such that the use of the control word is
       preferred, then send a Label Mapping message with c=1, and
       the control word is used.
- -iii. If the received Label Mapping message has c=1, and the VC is
        locally configured such that the use of the control word is
        not preferred or the control word is not supported, then act
        as if no Label Mapping message for the VC had been received
        (i.e., proceed to the next paragraph).

If a Label Mapping message for the VC has not already been received
(or if the received Label Mapping message had c=1 and either local
configuration says that the use of the control word is not preferred
or the control word is not supported), then send a Label Mapping
message in which the c bit is set to correspond to the locally
configured preference for use of the control word. (I.e., set c=1 if
locally configured to prefer the control word, set c=0 if locally
configured to prefer not to use the control word or if the control
word is not supported).

The next action depends on what control message is next received for
that VC. The possibilities are:
- -i. A Label Mapping message with the same c bit value as
       specified in the Label Mapping message that was sent. VC
       setup is now complete, and the control word is used if c=1
       but not used if c=0.
- -ii. A Label Mapping message with c=1, but the Label Mapping
       message that was sent has c=0. In this case, ignore the
       received Label Mapping message, and continue to wait for the
       next control message for the VC.
- -iii. A Label Mapping message with c=0, but the Label Mapping
        message that was sent has c=1. In this case, send a Label
        Withdraw message with a "Wrong c-bit" status code, followed
        by a Label Mapping message that has c=0. VC setup is now
        complete, and the control word is not used.

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

          -iv. A Label Withdraw message with the "Wrong c-bit" status code.
               Treat as a normal Label Withdraw, but do not respond.
               Continue to wait for the next control message for the VC.

     If at any time after a Label Mapping message has been received, a
     corresponding Label Withdraw or Release is received, the action taken
     is the same as for any Label Withdraw or Release that might be
     received at any time. Note that receiving a Label Withdraw should not
     cause a corresponding Label Release to be sent.

     If both endpoints prefer the use of the control word, this procedure
     will cause it to be used. If either endpoint prefers not to use the
     control word, or does not support the control word, this procedure
     will cause it not to be used. If one endpoint prefers to use the
     control word but the other does not, the one that prefers not to use
     it is has no extra protocol to execute, it just waits for a Label
     Mapping message that has c=0.

5.2.3. Status codes

     RFC 3036 has a range of Status Code values which are assigned by IANA
     on a First Come, First Served basis. These are in the range
     0x20000000-0x3effffff [note 2]. The following new status codes are
     defined:

          0x20000001 "Illegal C-Bit"
          0x20000002 "Wrong C-Bit"

5.3. LDP label Withdrawal procedures

     As mentioned above the Group ID field can be used to withdraw all VC
     labels associated with a particular group ID. This procedure is
     OPTIONAL, and if it is implemented the LDP label withdraw message
     should be as follows: the VC information length field is set to 0,
     the VC ID field is not present, and the interface paramenters field
     is not present. For the purpose of this document this is called the
     "wild card withdraw procedure", and all LSRs implementing this design
     are REQUIRED to accept such a withdraw message, but are not required
     to send it.

     The interface parameters field MUST NOT be present in any LDP VC
     label withdrawal message or release message. A wildcard release
     message MUST include only the group ID.A Label Release message
     initiated from the imposition router must always include the VC ID.

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

5.4. Sequencing Considerations

   In the case where the router considers the sequence number field in
   the control word, it is important to note the following when
   advertising labels

5.4.1. Label Mapping Advertisements

   After a label has been withdrawn by the disposition router and/or
   released by the imposition router, care must be taken to not re-
   advertise (re-use) the released label until the disposition router
   can be reasonably certain that old packets containing the released
   label no longer persist in the MPLS network.

   This precaution is required to prevent the imposition router from
   restarting packet forwarding with sequence number of 1 when it
   receives the same label mapping if there are still older packets
   persisting in the network with sequence number between 1 and 32768.
   For example, if there is a packet with sequence number=n where n is
   in the interval[1,32768] travelling through the network, it would be
   possible for the disposition router to receive that packet after it
   re-advertises the label. Since the label has been released by the
   imposition router, the disposition router SHOULD be expecting the
   next packet to arrive with sequence number to be 1. Receipt of a
   packet with sequence number equal to n will result in n packets
   potentially being rejected by the disposition router until the
   imposition router imposes a sequence number of n+1 into a packet.
   Possible methods to avoid this is for the disposition router to
   always advertise a different VC label, or for the disposition router
   to wait for a sufficient time before attempting to re-advertised a
   recently released label. This is only an issue when sequence number
   processing at the disposition router is enabled.

5.4.2. Label Mapping Release

   In situations where the imposition router wants to restart forwarding
   of packets with sequence number 1, the router shall 1) Send to
   disposition router a label mapping release, and 2) Send to
   disposition router a label mapping request. When sequencing is
   supported, advertisement of a vc label in response to a label mapping
   request MUST also consider the issues discussed in 5.3.1

Martini, et al.   [Page 14]

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

6. IANA Considerations

   As specified in this document, a Virtual Circuit FEC element contains
   the VC Type field. VC Type value 0 is reserved. VC Type values 1
   through 10 are defined in this document. VC Type values 11 through 63
   are to be assigned by IANA using the "IETF Consensus" policy defined
   in RFC2434. VC Type values 64 through 127 are to be assigned by IANA,
   using the "First Come First Served" policy defined in RFC2434. VC
   Type values 128 through 32767 are vendor-specific, and values in this
   range are not to be assigned by IANA.

   As specified in this document, a Virtual Circuit FEC element contains
   the Interface Parameters field, which is a list of one or more
   parameters, and each parameter is identified by the Parameter ID
   field. Parameter ID value 0 is reserved. Parameter ID values 1
   through 5 are defined in this document. Parameter ID values 6
   through 63 are to be assigned by IANA using the "IETF Consensus"
   policy defined in RFC2434. Parameter ID values 64 through 127 are to
   be assigned by IANA, using the "First Come First Served" policy
   defined in RFC2434. Parameter ID values 128 through 255 are vendor-
   specific, and values in this range are not to be assigned by IANA.

7. Security Considerations

   This document does not affect the underlying security issues of MPLS.

8. References

   [1] "LDP Specification." L. Andersson, P. Doolan, N. Feldman, A.
        Fredette, B. Thomas. January 2001. RFC3036

   [2] ITU-T Recommendation Q.933, and Q.922 Specification for Frame
   Mode Basic call control, ITU Geneva 1995

   [3] "MPLS Label Stack Encoding", E. Rosen, Y. Rekhter, D. Tappan, G.
        Fedorkow, D. Farinacci, T. Li, A. Conta. RFC3032

   [4] "IEEE 802.3ac-1998" IEEE standard specification.

   [5] American National Standards Institute, "Synchronous Optical
   Network Formats," ANSI T1.105-1995.

   [6] ITU Recommendation G.707, "Network Node Interface For The
   Synchronous Digital Hierarchy", 1996.

   [7] "Encapsulation Methods for Transport of Frame-Relay Over IP and
   MPLS Networks", draft-martini-frame-encap-mpls-00.txt. (work in

Martini, et al.   [Page 15]

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

    progress)

    [8] "SONET/SDH Circuit Emulation Service Over MPLS (CEM)
    Encapsulation", draft-malis-sonet-ces-mpls-05.txt (Work in progress
)

    [9] "Frame Based ATM over SONET/SDH Transport (FAST)," 2000.

    [10] "Encapsulation Methods for Transport of ATM Cells/Frame Over IP
    and MPLS Networks", draft-martini-atm-encap-mpls-00.txt. (work in
    progress)

    [11] "Encapsulation Methods for Transport of PPP/HDLC Frames Over IP
    and MPLS Networks", draft-martini-ppp-hdlc-encap-mpls-00.txt. (work
    in progress)

    [12] "Encapsulation Methods for Transport of Ethernet Frames Over IP
    and MPLS Networks", draft-martini-ethernet-encap-mpls-00.txt. (work
    in progress)

    [note1] FEC element type 128 is pending IANA approval. [note2]
    Status codes assigment is pending IANA approval.

9. Author Information

    Luca Martini
    Level 3 Communications, LLC.
    1025 Eldorado Blvd.
    Broomfield, CO, 80021
    e-mail: luca@level3.net

    Nasser El-Aawar
    Level 3 Communications, LLC.
    1025 Eldorado Blvd.
    Broomfield, CO, 80021
    e-mail: nna@level3.net

    Giles Heron
    PacketExchange Ltd.
    The Truman Brewery
    91 Brick Lane
    LONDON E1 6QL
    United Kingdom
    e-mail: giles@packetexchange.net

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

       Dimitri Stratton Vlachos
       Mazu Networks, Inc.
       125 Cambridgepark Drive
       Cambridge, MA 02140
       e-mail: d@mazunetworks.com

       Dan Tappan
       Cisco Systems, Inc.
       250 Apollo Drive
       Chelmsford, MA, 01824
       e-mail: tappan@cisco.com

       Jayakumar Jayakumar,
       Cisco Systems Inc.
       225, E.Tasman, MS-SJ3/3,
       San Jose, CA, 95134
       e-mail: jjayakum@cisco.com

       Alex Hamilton,
       Cisco Systems Inc.
       285 W. Tasman, MS-SJCI/3/4,
       San Jose, CA, 95134
       e-mail: tahamilt@cisco.com

       Eric Rosen
       Cisco Systems, Inc.
       250 Apollo Drive
       Chelmsford, MA, 01824
       e-mail: erosen@cisco.com

       Steve Vogelsang
       Laurel Networks, Inc.
       Omega Corporate Center
       1300 Omega Drive
       Pittsburgh, PA 15205
       e-mail: sjv@laurelnetworks.com

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

     John Shirron
     Omega Corporate Center
     1300 Omega Drive
     Pittsburgh, PA 15205
     Laurel Networks, Inc.
     e-mail: jshirron@laurelnetworks.com

     Toby Smith
     Omega Corporate Center
     1300 Omega Drive
     Pittsburgh, PA 15205
     Laurel Networks, Inc.
     e-mail: tob@laurelnetworks.com

     Andrew G. Malis
     Vivace Networks, Inc.
     2730 Orchard Parkway
     San Jose, CA 95134
     Phone: +1 408 383 7223
     Email: Andy.Malis@vivacenetworks.com

     Vinai Sirkay
     Vivace Networks, Inc.
     2730 Orchard Parkway
     San Jose, CA 95134
     e-mail: sirkay@technologist.com

     Vasile Radoaca
     Nortel Networks
     600 Technology Park
     Billerica MA 01821
     e-mail: vasile@nortelnetworks.com

     Chris Liljenstolpe
     Cable & Wireless
     11700 Plaza America Drive
     Reston, VA 20190
     e-mail: chris@cw.net

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002

Dave Cooper
Global Crossing
960 Hamlin Court
Sunnyvale, CA 94089
e-mail: dcooper@gblx.net

Kireeti Kompella
Juniper Networks
1194 N. Mathilda Ave
Sunnyvale, CA 94089
e-mail: kireeti@juniper.net

Internet Draft draft-martini-l2circuit-trans-mpls-09.txt   April 2002